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EDITORIAL

The Transport Problem Sir Kenneth Mitchell, Controller of Road Transport to the Government of India, in his presidential address to the Indian Road Congress held at Gwalior on 4th October 1943, has comprehensively reviewed the position of the roads and the various road problems in India and has made certain valuable suggestions for the improvement of the roads. The improvements that he envisages for the post-war period are ambitious, too ambitious in fact, and one wishes that it were possible to give effect to every one of them.

Everybody would agree with him when he says that the road-mileage in India is very meagre and that a large number of villages have not got even communicable roads connecting them with either district roads or highways. The extension of the road services to the villages would promote the material welfare of the country enormously. The inadequacy of the roads increases the transport charges unduly and handicaps the villager to a large extent in the efficient marketing of his produce. The villages not connected by proper roads are obliged to sell their grains at 4 to 12 annas less per bag than the roadside villages. The loss sustained by the cultivator in the villages not having road facilities can easily be imagined. It is enormous in the aggregate. The need for the provision of communicable ›ads requires no emphasis and the investment of money in village ›mmunications will be amply repaid in the increase of the welfare of the ›untryside. Such roads will also stimulate the production of commodities at enter a wider market.

Sir Kenneth has stated that motor transport has come to stay in India. nce pneumatic tyres and iron tyres (of the country cart) require different ›ad surfaces, for full and efficient service, the suggestion is made to ‹amine the possibilities of segregating the different classes of traffic on fferent roads, at least in places of heavy traffic and congestion. The ıplication is that at least in such places, two or more tracks will have to › laid side by side for the efficient movement of different classes of vehi- es, in place of the single track that exists ; the duplication to be instead the development and widening of the present roads to cope with the ‹panding traffic. It may be doubted whether laying such multiple tracks ›uld ever be possible or feasible in the case of a poor and undeveloped ›untry like India. We would rather suggest the extension of suitable

single-track roads to every village and their regular and proper maintenance, before laying multi-track roads is taken up for consideration. The country cart will remain the prime transport vehicle in India for a very long time to come and till then the road surface will have to cater to all classes of transport. It may not be eminently suitable for the fast motor traffic. But it is inevitable and admits of no possible remedy under the existing circumstances. The motor transport is no doubt increasing fast, but it can never replace the country cart which has its own place. Pneumatic-tyred bullock carts have been designed for use in the country. It might be that they do not wear out the roads, that the draught is reduced effectively and that they are in these respects highly efficient for transport of produce. But they are nearly three times as costly as the country cart *in normal times*, and the villager cannot simply afford it. Its use is restricted to the richer class, the community services and the various business and industrial concerns; the cultivator has not taken it up. Carts with deflated tyres cannot be used, proper pressure has to be maintained for preserving the life of the tread, the cart has to be protected from the sun and the weather when not at work, and repairs to tyres and tubes have to be attended to then and there: all these are beyond the capacity and means of the average villager. The poor *ryot* and his cart seem to be fixtures in the country's framework and it is against this background that any future development has to be planned, and this point is apt to be missed in an endeavour and even eagerness to make things progressive and speed up development.

Two things that merit the attention of the progressive industrialist have been singled out by Sir Kenneth, viz., the country cart and the indigenous water-lifts. Both of them are essential contrivances of a simple type and their basic simplicity, cheapness, service and ease of construction and repair in the villages without specialised skill and tools are a marvel; and unfortunately the modern engineer has not been successful so far in combining these several advantages in any improved design. Intense research is indicated; but there is no glamour about this type of work, spectacular results could not be expected and the problem has not gripped the imagination of the progressive, enthusiastic and ambitious research workers.

Absence of communicable roads is only one phase of the transport problem for the villager. An equally difficult, if not more difficult aspect of the problem is to provide himself with bullocks, feed for his animals, etc. The materials required for making carts and implements have become scarce and costly, especially iron which is almost unobtainable except at exhorbitant prices. Mr. S. V. Ramamoorthy, Adviser to H. E. the Governor of Madras, has indicated that the Madras Government are proposing to get 30,000 tons of iron and steel from the Central Government at controlled rates, and that these would be supplied to the cultivators for making carts and implements. That would give some relief. The high prices of cattle and feed are one of the many and varied effects of the war and we would wish that the war were won early, so that the people may be further spared from the effects of the vicious and demoralising spiral of inflated prices.

A Survey of Guava Cultivation in the Circars

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Introduction When "Grow More Fruit" has become the slogan of the day, a survey of a fruit crop such as guava, which is easily adaptable to a very wide range of climate and soil conditions and whose cost of culture and maintenance is cheap, is expected to be useful. Besides, such a survey was felt essential for making the guava varietial collection at the Agricultural Research Station, Anakapalle, comprehensive and exhaustive. Accordingly a survey of guava-producing regions in the Circars was undertaken in 1942, and the present paper embodies an account of the same.

Situation and nature of the tract The Circars lie to the north-east of the Madras province. The tract has a long period of dry weather, quite congenial to guava. With an annual rainfall of 50 to 60 in. in the hilly north and 30 to 35 in. in the plains of the south, the guava plantations enjoy the optimum precipitation range. Plantations of guavas are found mostly in well drained loamy soils. Guavas are also found to grow extensively in rich alluvial soil of the Kistna delta and red loamy soils of the Vizagapatam District. Extensive cultivation of this fruit can also be seen along the river Sarada in the Vizagapatam District, the river Kistna in the Kistna and Guntur Districts and the river Nalla Mada in the Guntur District.

Cultivation in the tract As the present survey's main object was the varietal study and collection, details regarding the area are not complete. However, figures got from the District Agricultural Officers of the concerned districts and in the course of the survey are given below:—

District	Area in acres
Vizagapatam	600
East Godavari	250
West Godavari	50
Kistna	350
Guntur	1,150
	2,400

Varieties and types No systematic classification of the varieties of guava has been done so far. Two distinct groups can be made out with the colour of the flesh as basis, namely—the white and the red fleshed types. The majority of the guavas belong to the white-fleshed group. Except one type known as the White Paria the rest of the whites are of good quality and go by the popular name of Calcutta guava. There is only one red type poor in quality and is known by the name of Red Paria. The White and the Red Parias resemble alike but for the colour of the flesh. A brief description of the guava types is attempted in this paper so as to enable the *ryot* to choose the right economic types or varieties for his tract.

A. *Calcutta types*

a) *Smooth peel types* i. *Meeranjee* This is a good commercial variety, the plant is a moderate sized shrub with pale green leaves. The fruit is big, round, smooth; peel light yellow coloured when ripe; flesh white, sweet, soft as butter, with few seeds and a strong flavour and weighs about 2 to 6 oz. Both the depressions at the stalk end and calyx end are of the same size. This variety bears in all the three seasons of the year. Fruits keep for 3 to 5 days.

ii. *Kurupum* This is a very good commercial variety; the plant is a moderate sized shrub with dark green leaves. The fruit is bigger than Meerangee, oval, smooth; peel golden yellow coloured when ripe; flesh white, medium sweet, soft as butter, with few seeds and weighs about 3 to 8 oz. The depression at the calyx end is 2 to 3 times bigger than at the stalk end. This variety bears in all the three seasons of the year and is a better yielder than Meerangee. Fruits ripen slowly and keep for 5 to 8 days.

iii. *Lakaram* Resembles in all respects Meerangee but for the medium size of the fruit with hard pulp inside which is sweet both when the fruit is ripe and unripe. The fruits keep for 5 to 10 days.

b) *Warted peel types—Kafri* A moderate sized shrub with green leaves and acute apex. The fruit is large, irregularly formed, warted and furrowed; peel golden yellow coloured when ripe; white fleshed with few seeds, moderately sweet, with little flavour. This variety stands transport best.

B. *Red Paria or Red Desi or Red Natu Jami* The shrub of this type is small with very small and dark leaves and is distinguished also by its habit of bearing more than one flower on the pedicel. The pulp is red with little flavour and is densely packed with seeds. This type is not economical to grow on a large scale.

C. *White Paria or White Desi or White jami* It resembles the Red Paria in all respects except for the white flesh inside.

The 'Calcutta types' seem to fit in the group of Pear-guava, the Red Paria in the Apple guava and the White Paria in the *Pisidium pumilum* as described by Firminger in his *Manual of Gardening for India*. There are also some other types like Neeradu jami, Seedless guava and Kasi jami which are seen as stray plants in some gardens.

Propagation and planting Propagation by seed is the common practice. Seeds are extracted from ripe fruits and are sown in the months of July and August in small raised seed-beds at a distance of one to two inches. Seeds take about 15 to 25 days for germination. The seedlings are not transplanted in nursery beds for hardening as in the case of other fruit trees but are directly lifted and planted out in small pits in the orchard, when they are 12 to 18 months old, at a distance of 15 to 25 feet from each other. Immediately after planting pot watering is done. Another watering

is given the next day and thereafter every alternate day for three months. Rarely manuring is done at the time of planting.

Later operations Watering is done in early stages on non-rainy days. The basins are small with no slope inside to keep off water from the trunk of the tree. A light pruning to remove the low-hanging and crossing branches is given whenever necessary. When the trees are young, inter-crops like *ragi*, *cumbu* and horsegram are grown in the Vizagapatam and Kistna Districts.

Bearing seasons The seedlings come to bearing in about the fourth year. If irrigated the trees bear throughout the year. But the chief bearing seasons in the Circars are as follows :—

1. *Tolakari Kapu* or *Mrigasira Kapu* (June-July) This season holds good in the Vizagapatam District only. Even there, a poor yield of about 100 to 300 fruits only per tree is obtained in this season. Owing to floods, this crop is not taken in the Kistna delta. The fruit of this season is not very sweet, but commands a good price due to the scarcity of the fruits in the market.

2. *Pedda Kapu* or *Sivarathri Kapu* (October-December) This is the main season and may extend up to February in the Kistna and the Guntur Districts. The yield may vary from 300 to 500 fruits per tree, but due to the glut in the markets the price secured is very low.

3. *Kotha Amavasya Kapu* (February-April) Because of the severe summer heat and poor yields, no special care is taken of this crop in the Kistna and the Guntur Districts. In the Vizagapatam District only, a small crop of the size obtained in Tolakari Kapu is got. Fruits fetch good price in this season also.

Harvesting and Marketing Fruits are harvested when they are half ripe. Harvesting is done by hand-picking from the lower branches and with an iron hook attached to a bamboo stick from the higher branches. In places where the market is near, the fruits are carried in *Kavadi* (two baskets tied one at each end of a small bamboo stick), and for long distances in carts and boats. Watching, harvesting and marketing are done by tenants. When fruits have to be sent to distant places like Calcutta, Puri, and Madras, middlemen intervene and snatch away a good profit. No systematic grading is done but rough sorting of big, medium and small fruits is often resorted to when the fruits are intended for export to distant places. The price of the fruit at the chief markets of Anakapalle, Rajamundry, Bezwada, Masulipatam and Guntur varies according to the availability of fruits in the market and the season. Generally, a basket containing about 50 big fruits, 100 medium sized fruits and 50 small fruits, is bought from the grower by the dealer or hawker at Rs. 0-8-0 to Rs. 2-0-0. The dealer sells the fruits after sorting at Rs. 3-0-0 for 100 big fruits and 0-8-0 for 100 small fruits.

Financial Return This differs widely from place to place. In the red soil areas of the Vizagapatam District and the dry sandy areas of

Masulipatam, where the Paria type is grown mostly, the annual income may be about Rs. 20 to Rs 30 per acre of 70 to 100 trees. In Anakapalle, gardens along the Sarada river, in the deltaic areas of the Kistna and in gardens along the Nalla Mada river the income may be about Rs. 100 to 150 per annum per acre of 50 to 80 trees which usually belong to the Calcutta variety.

Pests There are not many serious pests and diseases of guavas. The pests that do most damage are the birds, fruit sucking moths and scale insects. Birds are driven off by regular whatchmen or by the family members and sometimes by protecting the half-ripe fruits with dried leaves. Neither preventive nor control measures are adopted against fruit moths and scales.

Suggested improvements. It is evident from the survey that improvement is needed over a wide range, from selection down to the marketing of the produce.

Selection The first and the foremost attempt should be to replace the Paria type by the Calcutta guava types in order to improve the quality and increase the yields.

Propagation The *ryots* must be induced to grow vegetatively propagated plants, as such plants remain true to the parent in respect of quality and yield, besides bearing early.

Cultural practices Proper spacing and planting trees in lines by adopting the square or the quincunux method will enable one to have more plants in an acre. Root pruning is undesirable in open loamy soils as this is more or less a weakening process. 'Bending of branches' to bear more fruits is not a bad operation, provided it is done properly.

Irrigation and manuring From the experience gathered at the Agricultural Research Station, Anakapalle, it can be safely stated that manuring and irrigation induce more yields and increase the size of fruits.

Pests and diseases The importance of clean culture in the control of insect pests and diseases should not be overlooked. Infected branches should be promptly pruned out. Spraying with contact poison will check the scales and fruit moths.

Marketing Facilities for quick and easy marketing should be made, through the agency of co-operative organisations. A system of grading of fruits has to be adopted so that the market value of fruits may been hanced.

Preservation and canning The surplus fruit may be profitably utilised for the manufacture of such well-known products like guava jelly and dehydrated guava. The development of these industries is bound to improve the economic condition of guava culture. It is reported that excellent guava jelly and canned guavas have been prepared by the India Fruits Ltd., Kadiam, and at the Fruit Research Station, Kodur.

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A New Type of Jaggery Mould

By V. T. SUBBIAH MUDALIAR

Jaggery is made by concentrating sugarcane juice and allowing the resulting syrup to set hard. It is cast in various shapes-big buckets, balls of various sizes, slabs, small cubes, etc. Each cane-growing tract seems to have its preference for a particular type of mould. The choice of the mould-types may have been influenced originally by the type of cane grown in the tract, the keeping quality of the jaggery under the weather conditions prevailing in the consuming market, the fastidiousness of the consumer and the type of labour available for making moulds.

The Ordinary Mould The small "cubes" seem to be the most popular of the shapes. They are called "cubes", but are really frustums of square pyramids. Suitable shaped holes are cut in large numbers in wood and they serve as the mould for casting the "cubes". The concentrated cane-syrup is poured in the mould and after it sets, the mould is turned upside down and struck heavily with wooden mallets to shake the "cubes" out of the holes and they drop down. The "cubes" made all over the country are of the same shape, with wide variations in the size. The biggest "cubes" weigh half to a pound and the smallest a third of an ounce.

The moulds are generally made of *Babool (Acacia arabica), Vahai (Albizzia* sp.) and similar hard fibrous woods that can withstand the hard knocks given with wooden mallets to dislodge the "cubes". The moulds are about 15 ft. × 1 ft. 4 in. × 7 in., and would ordinarily have about 1,500 holes cut in it. The moulds cost (pre-war rate) Rs. 2-8 per hundred "cubes", inclusive of the cost of wood and making, at Coimbatore. The cost of the mould is high and cultivators prefer to hire the moulds during the crushing season, and avoid purchasing them. The moulds are heavy and difficulty is experienced in handling them. They tend to crack under the heavy malleting in the course of a few years. The frequent renewal of the moulds increases the capital outlay and the cost of making jaggery. Any improvement aiming at either reducing the cost of the mould or lengthening its life should be welcome.

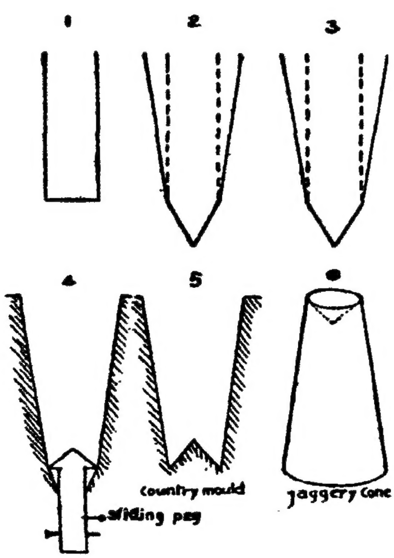
Attempts made to improve the mould have aimed at minor variations in the method of making, rather than at changing the shape of the holes. In the earlier years, the "cube" form was probably fixed upon as the only shape possible for the village carpenter with a few chisels to help him on. A tapering conical shape was not possible without the necessary tools.

The jaggery moulds have a flat pyramid provided at the bottom, called the *lingam*. The play of the chisel being limited by the narrowness of the hole, no other base is possible. No conceivable shape of the chisel could give a horizontal base.

The Peg-mould An improved type of mould appears to have been evolved a few years back, which may be called the 'Peg-mould', i. e.,

mould having pegs. The form and shape of the "cubes" made with both the ordinary and the peg-moulds are the same, but the pegged type eliminates the malleting done to shake the "cubes" out of the mould. Quality wood, free from knot and cracks is sawn into planks, planed to a thickness of $1\frac{3}{4}$ in. and used for cutting the mould holes. The holes run right through the wood and have a double taper as illustrated in Fig. 2. The hole at the bottom is closed by a sliding peg. The peg has a small stem and is surmounted by the *lingam*. When the mould is in position, the peg slides down and closes the bottom of the hole. The boiled cane syrup is poured in and it sets in a short time. The mould is then turned upside down and the pegs are pressed down lightly with the aid of a small plank about a foot square. The pegs in turn press the jaggery "cubes" and they drop down easily. The mould has the advantage of dislodging the "cubes" without the usual heavy malleting. The mould lasts far longer than the ordinary mould. The mould is further not heavy and is handled easily. The mould, however, costs Rs. 4 to Rs. 4—8 per hundred holes and a mould with 1,500 holes costs Rs. 65 and the prohibitive cost makes the extension of its use impossible, more or less. It has not come into general use, though a few moulds are made here and there by enthusiastic people. The mould is alright as far as it goes and the problem is to reduce the cost of making the peg-mould.

The Round-mould The round mould that is now suggested as an improvement embodies all the main features of the ordinary and the peg-moulds. The frustum shape that gives a distinctive appearance to the cube-jaggery and that facilitates its extraction from the mould is retained, but the hole is circular and the resulting jaggery is in the form of a truncated cone and which may be designated the 'jaggery-cone'. In other respects, it is just like the peg-mould. But the change from the square to the round form alters the method of making the mould completely. The planks are cut to size, planed and the centres of the holes are marked on the upper surface. Augur bits, having the same width as the small end of the truncated cone, are used for drilling the holes preliminarily as in Fig. 1. The depth of the hole is the same as the height of the "cone". The hole is then tapered with a special bit having a double taper shown in Fig. 2 & 3. This bit is made with longitudinal grooves, more or less like the grooving in rose-head countersink bits. The taper bit is regulated to pass through



1-4 Stages in making the round mould

the wood and just make a mark on the other side The sides of the hole can be smoothened with a tapering sand paper block, made for the purpose. The plank is then turned upside down and the hole marked already is enlarged to permit the stem of a sliding peg being inserted. The hole then takes the final form, fig 4 The sliding peg, is made of wood with a thin stem and surmounted by a flat cone. The peg is inserted in the hole and prevented from falling out by putting in a nail on the stem, an inch from the surmounting cone It provides a play of an inch for the sliding peg.

As has been seen, the circular mould is made in an entirely different manner. The technique of making the hole is a radical change and mould-making is speeded up. The drill makes the hole instead of the chisel and mallet. The mechanical efficiency of the hand is not such a big and important factor in making the moulds as in the case of the square moulds. A specially skilled workman turns out 80 holes in a day in the ordinary mould or 50 holes in the peg-mould. A skilled workman, not specialised, would drill a large number of round holes in a day.

With the size of wood and the labour for turning out the job reduced and the specialised workman set aside, the cost of making the moulds is bound to be considerably reduced. The precision in the round tapering holes, eliminates the possibility of "cones" sticking in the holes, as often happens in the squire holes, when the sides are lightly hollowed or bulged out. The round mould is likely to last fairly long with reasonable care.

The jaggery cones resemble the old cubes in general form and appearance and are not likely to be minded by the consumers, at least not after the novelty of the new shape wears off.

It is likely that small and minor difficulties will present themselves when the mould making is first attempted as with all new attempts, but they will, it is hoped, be overcome in the usual manner by local resource and talent.

Cultivation of Leafy Vegetables in the Northern Circars

By A. SANKARAM, B. Sc. (Ag.)

There is a great and real need for increasing the production of vegetables at present. With the present shortage of food grains, the use of large quantities of vegetables would to that extent relieve the pressure and make up the deficiency. Vegetables are valuable human food and our country is not having a sufficiency of vegetables in general. Among the vegetables, the leafy vegetables deserve to be placed high up in the list, as being highly valuable. They are rich in calcium, iron and other minerals and are therefore capable of making up the deficiency of minerals in the food grains, especially the polished rice and the various refined grain products. Also the greens abound in vitamins A and C, which are deficient in the staple articles of the South Indian diet. The greens may therefore be classed as highly protective foods. And the greens supply liberal

amounts of soft fibrous matter and bulk, which help the bowel action. All these together raise the metabolic efficiency,—digestion, assimilation, elimination of wastes from the system, final growth and maintenance of the health of the human system.

The common plants providing the leafy vegetables are the Amaranthus, the Indian Spinach and the *Gogu*. These are commonly raised by the market gardeners in the Northern Circars and the details of their cultivation are given under.

***Amaranthus gangeticus* L.** *Mokka or Perugu thotakura* (Telugu) and *Thondu keerai* (Tamil) The cultivation of Amaranthus is confined to garden land areas that have good irrigation facilities. They come up well in fertile, sandy and well drained loamy soils. The land is ploughed repeatedly—6 to 8 times – with a country plough to obtain good tilth. Beds 8 ft. by 8 ft. are then formed with irrigation and drainage channels in-between every two rows of beds. Small beds 4 ft. by 4 ft. are common in parts of North Vizagapatam.

Rotations and mixtures The Amaranthus crop comes up in rotation with *ragi* or any vegetable crop like brinjals or *bhendai* (Okra). Different species of Amaranthus are sown mixed in the same plot, also the Indian spinach, *gogu* and coriander sometimes Mixed crops are preferred, as the land available is limited in extent.

Season Amaranthus can be raised almost throughout the year. Three sowing periods are commonly recognised and by suitable adjustment of the sowings, a uniform supply of greens is provided for nearly a period of ten months in the year. The sowing periods are June, November and February. The first two season crops come up well and the February crop occasionally suffers for want of sufficient water supply.

Manuring The greens respond to heavy manuring. Cattle manure is applied up to 25 to 30 cartloads per acre. Sheep penning also is done in certain cases.

Sowings Sowing is done early in June for the *Tholakari* crop, in November for the Winter crop and in February for the Summer crop. The seed collected from the previous crop is used. Seed is collected from a few plants set apart in the field. The ripe and dried panicles are gently tapped and the seeds that shed are collected, winnowed and stored in cloth bags. Seed is also available in the local shandies for sale, at 12 annas per Madras Measure. Sowing is usually done in the cool evenings, preferrably after a rain. The seed is mixed with twice its volume of sand and broadcasted evenly over the prepared beds and lightly covered with soil. Two Measures of seed will sow an acre.

After-cultivation The seeds germinate in about a week and the plants put forth 3 to 4 leaves in a fortnight. Thereafter the plants make rapid growth, provided the supply of water is regular. The crop requires

copious irrigations and drainage is also equally important. The crop is weeded a fortnight after the sowings and hoed a week later. A second weeding is also done when necessary.

Harvest The crop is ready for harvest in 40 to 45 days from the date of sowing and it is done in stages. The harvest is spread over a period of three weeks and this ensures a steady and continuous supply of greens to the market. Further the sowings are also done in batches, in small areas each time, at intervals of 5 to 7 days. The harvest is done almost daily and the womenfolk themselves attend to the harvest and sale of the greens in the Vizagapatam District, without engaging extra labour.

Individual farmers cultivate up to a maximum of 30 cents of amaranthus. It costs Rs. 5 to cultivate an area of ten cents and the produce may be expected to be sold for about Rs. 10 to 12. Amaranthus is a popular green in the Circars and it finds a ready sale in the local markets.

Amaranthus gangeticus* L. *var. tristis—*Koyya thotakura* (Telugu) *Araikeerai* (Tamil). This is a variety of amaranthus which has a thin stem and a semi-trailing habit. This is cultivated just like the *Amaranthus gangeticus* mixed with other crops, and pure crops are not uncommon. This is raised in certain villages of the Vizagapatam District for providing fodder for work bullocks and buffaloes. It is supposed that the greens heat the system and reduces milk yields. It is not therefore fed to the milch animals. It is raised as a fodder in the same plot year after year, from January to August.

The *koyya thotakura* is considered inferior to *mokka thotakura* for human consumption and is available in the market at cheaper rates.

Amaranthus paniculatus—*Pedda thotakura* (Telugu), *Pungi keerai* (Tamil). This variety of amaranthus is very popular in the Vizagapatam district. The stems are very tasty and they are cooked and dressed in various ways. The variety largely cultivated round about the village of Rega goes by the name of *Rega thotakura*. This is particularly valued in and around Vizianagaram and is always in good demand. While the rind of this variety is hard, the inner medullary portion is soft and sweet and is much appreciated by the consumers. Other varieties of amaranthus are not known to have this special characteristic.

Cultivation About half a Measure of seed sown in a 5 cents nursery will plant out an acre. Seedlings, 2 to 3 weeks old, are transplanted 1½—2 ft. apart either way in the main field. The seedlings planted in May are ready for harvest in October. When sold wholesale, the crop fetches Rs. 150 from an acre of the crop. Four to eight plants per anna is the retail rate in the market.

***Basella rubra* L.**—*Mattu batchalakura* (Telugu), *Pasalai keerai* (Tamil). This is the Indian spinach and the soil, tillage and manurial requirements are the same as those of amaranthus. Two crops are ordinarily raised, one in June and the other in November.

Sowing The green is raised as either a pure crop or mixed with amaranthus. Half a Measure of the seed will broadcast an area of 10 to 12 cents. Seedlings are also raised in nurseries and transplanted $1\frac{1}{2}$ ft. apart either way, by the middle of June. Ten to fifteen days old seedlings are used for transplanting. The crop may be given 4 to 5 irrigations in all.

Harvest Side shoots alone are harvested once in 10 to 12 days, in places like Bobbili. In general entire plants are pulled out just before flowering in other places, for sale in the local market. A plot of 10 cents will yield 80 to 100 baskets of greens valued at Rs. 10 to 12, and the cost of cultivating the area is about Rs. 5. The green is used in soups and is in fair demand.

***Basella rubra* L.**—*Pedda or Theega batchali* (Telugu) This trailing variety of the Indian spinach is grown for the market, in parts of East Godavari, round about Peddapuram and Pithapuram and to a limited extent, in the backyards of houses, in parts of Vizagapatam, round about Bobbili and Parvathipuram.

Cultivation Pits are made 10 to 12 ft. apart and 6 to 8 seeds are sown in each pit, in either June or October. *Pandals* are put up for the vines to climb and spread out. After the germination of the seeds, two or three vigorous plants are retained and the rest are pulled out. As these plants grow, they are trailed on the *pandals*. A *pandal* 20 ft. × 20 ft. will accommodate 4 pits. The pits are manured with cattle manure at 2 to 3 baskets per pit, a fortnight after sowing. The application of red earth to the pits is also common and it is said to accelerate the growth of the vines The plants cover the *pandal* in $2\frac{1}{2}$ to 3 months, when the tender side branches are gathered periodically. Both the stems and leaves are used in making soups. The cultivation of this green is after all done to a limited extent only.

The Indian Sorrel *Hibiscus cannabinus* L., ***Gongura*** (Telugu), *Pulimanchi* (Tamil). The Indian sorrel is a tall undershrub which is cultivated extensively in the Circars and the Ceded Districts. The leaf is sour and is used largely for making chutney. The leaf obtained from a crop grown mixed with *Variga* in dry land is said to be the best for purposes of preservation. The leaf is fried with a small quantity of salt and kept in storage as a stock material for preparing chutney, when required.

The crop is deep rooted and is not exacting in soil, irrigation and manure requirements, like the other greens. It is grown in the dry soils, mixed with redgram, and rarely as a pure crop. The sowings are made in June, November and February. A pure crop requires 5 to 6 lb. of seed per acre. If the soil moisture is adequate at sowing time, the crop may be expected to come up well with the usual rains. The leaves are picked once a week, from the eighth week onwards for about $3\frac{1}{2}$ months. A plot of 10 cents will yield greens valued at Rs 6.

SELECTED ARTICLE

Soil Physics: Theory and Practice* (*Abstracted*)

By Dr. B. A. KEEN, F. R. S.

I. SOIL PHYSICS: ITS SCOPE IN AGRICULTURE

Agricultural science as we understand it today is a young growth. It is only in the past 25 years or so, that any considerable number of trained and competent scientists has been engaged in agricultural research, and with rare exceptions the agricultural laboratories have not celebrated a Golden Jubilee. The soil physicist was a relatively late arrival; there was no physicist on the Rothamsted staff until 1913.

The primary contribution of physics to agricultural science is obviously in the study of the soil, its physical properties, the laws governing the retention, movement and loss of water, and the bearing of these laws on plant growth. The practical applications of this knowledge largely concern the operations and their effect on soil moisture and on plant growth. Those are the main subjects embraced in soil physics: theory and practice.

Soil is, from the physical view point, a mixture of particles of all shapes and sizes ranging from sand grains and rock fragments a millimetre or so in diameter down to minute particles of clay or clay—like minerals. Every one knows the difference between a clay soil—a heavy soil as the gardener or farmer calls it—and a light or sandy soil: the latter has more coarse and fewer fine particles than the former. The Agricultural scientist requires a more exact and more objective specification than the term 'heavy' and 'light' and this has been met by the method known as the mechanical analysis in which the particles are sorted out into a number of groups of decreasing size.

In all methods of mechanical analysis the soil is mixed with water and treated to disperse any clusters or aggregates into their individual particles. The coarser particles are then separated under water by sieves of suitable mesh, while the small ones are graded by using the fact that the smaller the particle the more slowly it sinks in still water.

The table below gives the group names, the range of settling velocities and the equivalent radii of the particles, calculated from Stokes' Law, assuming that every soil particle is a perfect sphere. The equivalent radius is a convenient fiction which provides a more concrete picture of particle sizes than does the velocity of fall in water.

Name of group	*Range of radii mm.*	*Upper velocity of group—cm. sec.*	*Log. v*
Coarse sand	10—0·1	350	2·54
Fine sand	0·1—0·01	3·5	0·54
Silt	0·01—0·001	0·035	$\bar{2}$·54
Clay	Less than 0·001	0·00035	$\bar{4}$·54

The characteristic property of coarse and fine sand fractions is their inertness. Soils containing high proportion of them hold little water and are of low inherent fertility. Nevertheless they are an essential constituent of soil. They keep it open and thus improve the natural drainage, aeration and ease of cultivation.

The silt particles pack more closely together than any other soil constituent. Soils containing much silt—15-20%, are difficult to work and drain. Liming has

* Cantor lectures delivered on 19th and 26th January and 2nd February 1942.

little effect on silty soils as, unlike clay, silt does not possess marked colloidal properties.

Clay is the most distinctive of all soil constituents. It is the weathered and chemically reactive portion of the soil, while others are inert. It displays marked colloidal properties Its most striking property is the power to form crumbs or aggregates, consisting of many individual particles bonded together. Clay soils are retentive of water and drain only slowly. They warm up less rapidly and cool more slowly than sandy soils. They offer high resistance to cultivation implements. When wet, clay soils tend to become sticky and shrink on drying.

Much work has been done on the properties of the soil in bulk. The goal has always been what may be called a 'single value' measurement ; some experimental procedure in which an outstanding physical property, or group of properties, would be specified by one numerical value, and thus serve as a simple means of grading or classifying soils. Such single values can clearly have only a general significance.

One difficulty that besets the prediction of soil behaviour in the field from the results of single value determinations is that many of these necessitate the soil being in a finely divided condition. The natural crumbs have to be broken down mechanically and the main characteristic of the field soil is, therefore destroyed. The crumbs are aggregates of individual clay particles in which some inert and larger particles may be enmeshed and they are permeated by minute interstices. Between the crumbs there are larger pore-spaces. Thus the soil interstices consist in essentials of a micro-pore-space in the crumbs and a macro-pore-space between them. In this pore-space water moves or is retained under the influence of gravity, evaporation and absorption by plant roots; within it also the soil air, which is richer in carbondioxide, inter-diffuses with the outside atmosphere.

The Capillary tube hypothesis and its failings In their attempts to explain the water relationship of soil, the earlier workers missed the implication of these two sets of pore-spaces. They used the simple fact that the soil was porous and pictured it as a set of capillary tubes : irregular in width, length and direction, it was true, but none the less capillary tubes, to which the simple and familiar tube formulae from pure physics could be applied. The result was the general belief that when the soil moisture content was reduced by evaporation or plant absorption, water was drawn up by capillary attraction from the ground water table to replace it. The hypothesis also gave an apparently sound scientific explanation of the effects of hoeing, harrowing and rolling. This emphasis on the direct association of the ground water table with agriculture persisted in spite of the failure in laboratory experiments to get water to rise more than 3 feet or so even in fine textured clay soils. This difficulty was comfortably dismissed by assuming that the packing of the soil in the laboratory was different from that in the natural field conditions. But experiments conducted over a long period at Rothamsted showed that even after several months of practically continuous evaporation conditions the water level sunk only about 3 feet in the clay soil, about 2 feet in fine sand and just over a foot in coarse sand. The above discrepancy between the experimental results and the original theory could not be easily set aside. Actually the soil-water largely remains *in situ*, as it meets the changes by automatic alterations in the curvature and thickness of films of water about the soil particles. Soil water is resistant to changes and is not drawn from wetter to drier regions, as asserted by the capillary theory.

Some fallacies in drainage and irrigation The failure to understand the role of water in the soil has led to certain erroneous ideas and practices in land

irrigation and drainage. In many experiments laid out to determine the optimum quantity of water and spacing between irrigations, it was assumed that the added water distributed itself uniformly throughout a considerable depth of the soil so that the moisture content is everywhere raised from its previous value to a new one. This is not what happens. In the immediate vicinity of the ditch the soil pore-spaces become quickly saturated. The film curvature in the adjacent pores is disturbed and water passes into them from the first set, which are replenished from the water in the ditch. The process continues until all the water in the ditch has entered the soil. At this stage the soil around the ditch is saturated; the volume of saturation depends on the amount of added water and the initial moisture content of the soil. Then there follows a much slower redistribution, in which the saturated cells part with some of their water to emptier cells adjoining the saturated zone, and the action extends back slowly into the saturated zone itself. But this process cannot, over any reasonable space of time, reduce the moisture content to a point lower than a value called the "field saturation capacity," which, for practical purposes, represents the moisture content that the soil can hold against the pull of gravity. So, ultimately, an application of irrigation water wets a certain volume of the soil up to the field saturation capacity. Beyond the boundary of this zone the moisture content may be appreciably less, but appropriate curvatures in the waterfilms will maintain approximate equilibrium between the wetted volume and the adjoining soil.

A 5 ft. depth of freely draining soil holds the equivalent of at least 7½ in. of rain which, with the rain that falls in the growing season, is more than ample for the water requirements of plants. Roots of the common agricultural crops given fair conditions will ramify throughout most of this depth. Remembering that the maximum height of capillary rise, even in heavy soil, is shown by Rothamstead experiments to be only 3 ft., it follows that if the water-table level is lower than 8 ft., the sum of these two values, it is in practice incapable of supplying water to the plant roots. If the water-table level be less than 8 ft. below the surface, it is true that in long droughts the plants may get some of the water. But it is equally true that in wet periods the water-level will often rise into the 5 ft. zone, temporarily checking root activity and causing deterioration in the soil structure. We may therefore take 8 ft. as a fair figure for the critical value of the water-table depth. Soils with a higher water-table than this may well "derive benefit or avoid danger" as a result of new drainage works.

II. SOIL CULTIVATION: ART OR SCIENCE?

Soil tilth The pore-space in the soil is essentially cellular in nature. There are relatively large pores connected together by narrow necks, easily visualised in the case of sandy soils. These pores are the macro-pore-spaces. In the clay soils, aggregates of small particles of clay exist and the aggregates behave like individual particles. There are pores, relatively small, in-between the small ultimate clay particles constituting the aggregates and these pores are the micro-pore-spaces. The pattern of the macro-pore-space between the crumbs and the micro-pore-space inside the crumbs is highly developed in clayey soils. A soil in good tilth—that is in a definite crumb structure—is immediately recognised by the farmer and similarly its converse also—bad tilth, where the structure is destroyed.

Recent researches have led to some interesting conclusions regarding crumb formation: (1) the particles must be less than 0·0005 mm. in diameter, (2) crumb formation is connected with the active or negatively charged spots on the clay and the base exchange capacity of the clay is a measure of this property; (3) these exchangeable ions must be small; (4) Crumbs are formed from the wet

clay when the liquid is removed by drying, or by freezing and (5) the crumbs do not form with every liquid. When all these conditions are fulfilled, crumbs will form, the clay particles and the exchangeable ions being held together by water bridges or chains. The water molecules may be regarded as 'bound' to the clay in the sense that in this condition, their properties are somewhat changed from those of water in bulk. Crumbs do not disintegrate when re-wetted and they are known to have a degree of stability.

Stability shows itself in one or both of two forms—mechanical and water stability. By the former we mean the resistance to mechanical forces of rupture such as the pressure of strong winds, the impact of a rain drop, and certain cultivation operations. In general mechanical stability is assured if there is enough colloidal material present. Water-stable crumbs retain their individuality when wetted with water. They will swell and alter their shape, but will not fall down to paste: when the excess water is removed the soil remains in crumb structure Soils which contain exchangeable sodium ions are not water stable.

Rapid drying and rapid freezing produce small crumbs An increase in the salt content of the soil also reduces the crumb size. A study of the crumb structure of soils in natural conditions is one aid in deducing the history of their formation and in classifying them into types and groups.

Weather and cultivation implementsas factors in tilth production Cultivation implements have little direct control over tilth production. Their main function is to leave the soil in the best condition for the weather to act or conversely to complete the effect of the weather. The lumps are permeated by lines of weakness already created by preceding weather conditions, and when the harrow teeth, for example, strike the lumps and compress them against one another, they break down along these lines of weakness. To some extent the disc type of implement is an exception in that it does produce more direct disintegration than the standard implements. If owing to unfavourable weather, the soil is in an unkindly condition and seed-bed preparation is behind-hand several harrowings with disc harrow will produce a passable seed bed when other methods would fail. A tilth of this kind is appropriately referred to as a 'forced' tilth.

Ploughing produces a shearing action on the soil and accentuates within the clods any incipient lines of weakness along which disintegration will later proceed; but it does not necessarily produce any considerable comminution at the time. The breaking down of clods to a tilth is connected with alternations of drying and wetting of the soil. The explanation is that during shrinkage the stresses produced when the particles closely approach one another, set up strains within the block which give rise to lines of weakness. The air absorbed on particles' surface in the later stage of drying is evolved suddenly when the block is re-moistened and produces small fissures along the lines of weakness. Thus alternations of wet and dry spells during the winter will shatter down an initially plastic clod of soil into fragments.

Cultivation and the control of soil moisture The operations most concerned are hoeing, harrowing and rolling. The capillary explanation of the function of harrowing and hoeing was that the top ends of the narrow capillary tubes were severed and replaced by the large pore-spaces of a loose soil mulch. The water was therefore unable to travel higher than the bottom of the mulch and thus its evaporation into the air was prevented. There are fundamental objections to this view. In the first place the vast majority of the soils are self mulching i. e., they automatically form a dry surface layer during periods of sustained evaporation. It follows logically that hoeing and harrowing are redundant operations in the direct conservation of soil moisture. In the second place the correct

theory of water movement explained already showed that the water films resist movement by adjusting their curvature to suit the changing suction of pressure deficiency. When evaporation occurs from a moist soil the water films at and very near the soil surface become attenuated to a sharper curvature. There will be local readjustment of the moisture distribution in response to the change but little or no upward movement of the water. In sequence water films a little deeper in the soil will decrease in volume and increase in curvature because they part with their water as vapour, which diffuses through the pore-spaces into the atmosphere. The result is that an air dry layer of soil is formed which gradually increases in thickness; below it there is a very narrow transition zone where the film curvature is affected by the high pressure deficiency of the air dry layer immediately above; below the transition zone the moisture films remain relatively unaffected by what has happened above.

The primary function of hoeing is to destroy weeds, which compete with the crop plants for food and water. This competition is much more serious in the early stages of growth than is usually supposed. A secondary function of hoeing and harrowing is of some importance on those soils that form a surface cap or crust when they dry out; in addition to root injuries caused by the contraction of the crust, the large cracks between the clods afford a ready way of escape for soil moisture from below. Cultivation at the time of incipient crust formation will shatter the soil into small pieces and avoid both these dangers. Thirdly, surface cultivation at frequent intervals, by inhibiting the growth of shallow roots, might possibly encourage deeper rooting, but this requires to be tested out.*

The traditional explanation of rolling was that by compressing the top layers of soil it reduced the average size of the voids which were thus able to draw water by capillary action from the larger voids below the compressed layer. However for this action to occur, the moisture content of the soil would have to be so high that no practical man would order the operation for fear of damage to the tilth. The real effect of rolling is to press the soil closer around the roots of the young plants. Alternations of wet and dry weather cause a loosening of the soil and freezing causes the soil to "heave"; both these causes loosen the hold of the young roots on the soil. Rolling presses the soil back into contact with the roots.

In the above explanation of hoeing, harrowing and rolling there is inherent a view of the manner in which the plant roots gain access to soil moisture. The capillary theory conferred on the soil the active role in the duty of supplying the plant with water—that of water moving from higher to lower moisture regions. But in reality the plant roots themselves go in search of the moisture because the adjustment of films of curvature prevent more than a limited movement of soil-water. At the beginning of the growing season moisture up to the field saturation capacity is stored in the soil in the micro-pore-spaces of the crumbs, which can be looked upon as little reservoirs, and in films around the boundaries of macro-pore-spaces between the crumbs. Even a reputedly shallow-rooting plant like barley sends down its roots to 5 ft. below the surface. Hence, the extensive root range of plants and the capacity of the soil to store moisture

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* It might be possible fourthly that the surface cultivation at suitable intervals favours weathering and the conversion of the plant food in the soil into soluble forms appropriate for plant feeding. Possibly also the soil nitrogen and the changes it undergoes in the soil are influenced, *vide* inter-row cultivation effects, pages 294-295. The low nitrogen plots are benefitted by frequent hoeings, but not the high nitrogen plots—in some cases the effects were even negative. (*Ed*).

are complementary functions which together will meet the normal water requirements of the crop.

III. CULTIVATION AND CROP YIELDS

Traditional views in Britain The evidence marshalled justifies the revision of the older views on the relations between the soil and its water content. One conclusion was that *cultivation does not have any important direct effect in controlling the moisture content*, although a great body of tradition asserts the contrary. To the practical men, the cultivation was one of the means of growing the best crops and experiments were started at Rothamsted to prove the obvious—good and thorough cultivation resulted in good crops, and to confirm the views held by practical men: falling off in yields is produced by insufficient cultivation. Slowly, but surely, we have been forced to revise our ideas, for the results have shown that *yields are remarkably insensitive to variations in cultivation.*

RESULTS OF MODERN EXPERIMENTS

Sub-soiling Subsoiling appears to be an unnecessary and unprofitable operation on the Rothamsted soil possibly because the sub-soil although a heavy clay has natural fissures down which surplus water can escape and roots can grow.

Extra ploughing It is generally held that ploughing in autumn and again in spring is desirable in preparing for root crops. Two experiments were conducted and a practical outcome, reinforced by a number of observations later, is that autumn ploughing could be omitted without harm and when given the spring ploughing is seldom needed, at Rothamsted.

Depth of ploughing Deep ploughing has a better effect when the land is weedy. Shallow ploughing is on the average as effective as deep ploughing (Rothamsted results).

Comparison of ploughing and grubbing When the land is not weedy the grubber can replace the plough for a season or so without detriment to the yield. The grubber is not able to control the weeds as efficiently as the plough.

Comparison of ploughing and rotary tillage If the land is clean, as it usually is after a root crop any method of getting a reasonable tilth quickly can be used. The depth of the tilth is not very important provided it is clean. Though yields may be less with rotary cultivation, the reduction is small and may be offset by economy of time and labour.

Degree of consolidation of seed bed Experiments were designed to test whether heavy rolling of a seedbed would have any effect on yield. Rolling improved the stand and early growth, but not the yield. The result showed that quite striking differences in the early growth do not by any means imply that there will be corresponding differences at harvest time.

Intercultivation of root crops With kale, sugar beet and potatoes, the control plots were given the normal number of inter-row hoeings in a number of experiments and the other plots were given extra hoeings. Intensive cultivation produced significant reduction in yield. The extra labour and cost of cultivation were wasted and smaller crop was obtained, in general, in most cases.

Certain experiments were designed to answer the question whether hoeing has any effect on crop yield beyond that attributable to weed destruction. Hand pulling of weeds was compared with hoeing, with two levels of nitrogenous manuring. Hoeing was superior to hand pulling in every case, which would suggest that the operation of hoeing contributes something besides the mere destruction of weeds. Part of the superiority was however due to the hoe being more effective against weeds. Extra cultivation produced increases in yield in

the low nitrogen plots; the increases were less in the high nitrogen plots and in some cases even negative (Woburn, Rothamsted and Chertsy results).

American results A number of American results were considered. They were in close agreement with the results discussed above. With the bulk of a large number of experiments, comparing normal cultivation and surface scraping, there was no advantage of normal cultivation over surface scraping. The obvious conclusions are that the general statement that hoeing is beneficial is inapplicable as a generalisation, and that the primary effect of cultivating to produce a soil mulch is in reality weed destruction.

The tradition of good cultivation The extensive discussion given above has covered a wide variety of operations and a wide range of conditions. The results, even on a cautious interpretation, lend no support to the idea that extra cultivations increase crop yield: they show that, provided (a) a reasonable seedbed is obtained, (b) weed competition is prevented during the early growth of the crop and (c) the worst of the weeds are kept down afterwards, then any work in excess is wasted and may even be harmful as far as the crop yield is concerned. On the other hand, they do emphasise the importance of choosing the right time for cultivation.

It may well and rightly be asked, if this be so, how was it that the tradition ever grew up? The following explanation may be provided. The old agricultural system favoured weeds, the implements were clumsy and inefficient and frequent cultivation was the only hope of the farmer; this was possible with the cheapness of labour. Further horses and bullocks used for draught did not cost more, when worked. Even when efficient tools were devised in later years, the old tradition of 'keeping the hoe moving' was maintained. Things have changed; labour is costly; power hauled implements have come to stay in the farm and the more they are used the greater is the running and depreciation charges. There is no place now for cultivation based on custom and tradition. What is necessary should be done, but parsimony as well as extravagance in cultivation are economic blunders in farming today.

Conclusions The bulk of the experiments discussed were done at Rothamsted and Woburn. The practical results were brought to the notice of the farmers by the agricultural press, lectures and addresses. In all these, stress was laid on this central point. No claim is made that many cultivation operations, now accepted as necessary, are a waste of time and money on all soils. It is also urged that in view of the results obtained at Rothamsted and Woburn, other soils should also be examined in a similar manner.

The response to this proposal has been disappointing. Possibly because there is nothing advertisable in our findings and that has a sale value in the market like the improved manures, sprayers, implements, feeding stuffs etc. The change in cultivation technique, the consequent saving in expenditure and their application are subjects for demonstration and education and it is the business of the State, for nobody else can be expected to be interested in the dispersal of such knowledge.

Agricultural research has made vast strides in this century. These also show that generalisations could not be made from a set of results based on one soil, climate, agricultural system etc. The results need not necessarily be valid elsewhere. For rapid changes that may have to be made in post-war agriculture, a reliable basis with field experiments on a national scale would be necessary. This is the immediate need of the day. C. S. K. *(J. Roy. Soc. Arts, Vol. 40, 546—579, 1942.)*

Abstracts

Improvement of the Nitrogen of Soils and the Origin of Soil Nitrogen by Prof. N. R. Dhar (*Nature, Vol. 151; May 22, 1943*). It appears that the fixation of atmospheric nitrogen can take place in the soil not only with the help of Azotobacter, but also in the complete absence of bacteria as a surface process aided by sunlight; the chief source of nitrogen in soil in all countries is this type of fixation and not that supplied by the leguminous plants as is believed. Even when sterile soil containing various carbohydrates is exposed nitrogen is fixed. The fixation takes place even in darkness, but at a retarded rate. The carbonaceous matter is oxidised and the energy liberated leads to the fixation of atmospheric nitrogen. When bacteria are present in the soil, the rate of fixation of nitrogen is greater than in the case of sterile soils.

The fixation of atmospheric nitrogen is brought about in a similar manner when mineral surfaces are exposed under identical conditions. The efficiency of fixation is greater with minerals than with soil. The fixation of nitrogen is opposed by loss due to nitrification, as both the processes are at work simultaneously. Ammonium nitrate, which is unstable, is formed during the nitrification of the proteins and other nitrogenous compounds produced by fixation or originally present in the system. In soils, there is a stock of combined nitrogen, which is also subject to a certain amount of loss. Hence the nitrogen lost is greater in soils than in minerals and the sum total of nitrogen added is greater in the case of minerals and therefore the greater efficiency of the minerals.

The parent materials from which soils are derived are pure mineral substances. They do not contain organic matter, but may have traces of nitrates and ammonium compounds, sufficient to promote the growth of algae primarily. The algal matter offers the nuclear organic matter for oxidation and fixation of nitrogen consequently. In course of time the stock of nitrogen increases, as also organic residues resulting from photosynthetic activity and fertile soil is eventually formed. The fixation of nitrogen is rapid in the beginning and as the stock of organic matter and nitrogen increase, the process slows down and a balance or normality of nitrogen content is attained depending upon the climate. The fixation of nitrogen in the minerl matrix induced by the oxidation of organic matter in the presence of light plays a prominent part in the formation of soils in general.

The residual effect of cow manure may be due not mainly to the conservation of nitrogen as is believed, but to the fixation of atmospheric nitrogen through the oxidation of the carbonaceous material present aided by sunlight.

In Indian soils under cultivation, the total nitrogen is much lower than in soils of temperate climates. The prevailing high temperature and the intense sunlight accelarate the oxidation of carbonaceous and nitrogenous compounds in the tropics thus entailing loss of nitrogen by nitrification of the nitrogenous compounds in the soil. When the land is covered with vegetation such losses are reduced and nitrogen content is raised, as in grass lands. When cultivation is taken up again, the nitrogen content falls down to the normal. By the addition of organic matter, the nitrogen content is raised both due to the fixation of atmospheric nitrogen and to its conservation in the soil.

The intense sunlight and heat prevailing in the tropics make available greater quantities of nitrogen from the soil than in the temperate climates. The available nitrogen in tropical soils is 10—30 per cent of the total nitrogen (0·04—0·05 %), while it is only 1—2 per cent of the total nitrogen (0·1—0·2 %) in temperate

soils. That explains why under unmanured conditions, a better crop is had in the tropics than in the temperate regions. By adding molasses or other easily oxidisable carbonaceous substances to the soil, the nitrogen content of the soil is improved by nitrogen fixation. The content of ammoniacal, nitrate and total nitrogen are the highest a month or five weeks after application of molasses and that is the time for sowing the crop in the field for best results. V. T. S.

Tomato cultivation in the College Farm by B. F. Topper (*Tropical Agriculture, Trin Vol 19 No. 9, Sep. 1942*) The seeds are sown in nurseries in early November, using one ounce of seed for two square yards. They are covered by sprinkling over a thin layer of soil and this is compacted by beating with a piece of board. One ounce contains 9,000 seeds and gives 4,140 seedlings on the third day and 965 transplants five weeks later. The beds are watered and covered with coconut leaves. The shade leaves are removed to structures above the beds, when the seedlings come up. The shade is removed when the seedlings are strong enough. When the seedlings are one or two weeks old, they are pricked out 4 or 5 inches apart in manured beds. Water is applied sparingly during the last week to harden the plants.

Transplanting is done in early December when the seedlings are 5—6 weeks old. Bamboo stakes 6—8 ft. long are planted firmly 4—6 in. away from each plant. In 1942, with plants on ridges 3 ft. apart, 1 ft. spacing was significantly better than 1½ ft. spacing, which in turn was better than 2 ft. spacing. Staked and pruned plants did better than unstaked and unpruned plants.

Pruning Early in January the plants were tied to stakes with the inflorescence away from the stakes, to avoid the fruits getting bruised, and the side branches were pruned. The pruning and the tying of the plants is attended to once a week. When the plants are four months old, they get out of reach and are then topped, but a side branch is allowed to develop in place of the main growing shoot.

Manuring Compost is ploughed in, at 10 tons per acre preliminarily. Mixed fertilizer ($1N:4P_2O_5:3K_2O$) at 1,260 lb. per acre is applied in three monthly instalments, the first after transplanting placed in holes 6 in. away from the plant. Each plant receives on the whole about 2 oz. of artificial fertilizer mixture. V. T. S.

Food Yeast by Dr. A. C. Thaysen (*Nature, Vol 151, April 10, 1943*) During the last war it was shown that proteins could be synthesised from inorganic salts, including ammonia, by growing yeast in worts containing sugar as the only organic substance. In 1915, Hayduch reported that he had succeeded in synthesising protein using ammonia in the process with the help of an yeast—presumably a species of Torula—which produced little alcohol only, when compared to others. It may be claimed that yeast-protein is only slightly inferior to animal protein. It is also known that yeast constitutes the most valuable source of water soluble B vitamins.

Work on production of yeast was commenced by the Department of Scientific and Industrial Research in the chemical research laboratory at Teddington (Jamaica) in 1940. A polyploid strain of yeast, provisionally named *Torulopsis utilis* var. *thermophila*, was found suitable for the purpose. This strain is bigger in size than the ordinary yeast, facilitating the separation of the cells from the culture medium and is capable of developing under conditions prevailing in the tropics. During the usual nine hour growth period at Teddington, this strain produces a fifteen-fold increase in the weight of yeast introduced as the inoculant. The yield of dry yeast produced at the pilot plant is 30 per cent on the molasses used, containing 50 per cent sugar. The yield of protein in the yeast, calculated on the inorganic nitrogen supplied, represents almost theoretical conversion.

The yeast produced is carefully washed and the pure yeast suspension is passed over drying rollers, resulting in light straw coloured thin flakes, named "Food-Yeast", having a pleasant meaty and nutty taste. The Food-Yeast has a protein content of 45–50 per cent and is a potent source of B vitamins, of which it contains the whole range known. It is readily miscible with water, milk, etc. It could be mixed and baked with loaf and biscuits. It is estimated that this could be put in the market at 6d. per lb. and a daily intake of half an ounce per head is contemplated. It is stated that in suitable cases, when Food-Yeast was given with added ascorbic acid, improvement in or disappearance of some pathological senile features was noticed.

It may be claimed that Food-Yeast can supplement a diet lacking in animal food and should be particularly valuable in occupied countries, where there is bound to be animal food shortage during the post-war reconstruction period. Yeast production can be completed in hours, if a certain amount of carbohydrate food is set apart for it, while meat production may take as many years. One acre of a carbohydrate crop can yield 840 lb. of yeast protein or 70 lb. of meat or milk protein. The proportion of vitamin B would be much higher. At present prices meat protein would be 5 times dearer, milk protein 8 times and egg protein 24 times, when compared to yeast protein. The B vitamins of meat and milk protein would be 25 times and egg proteins 80 times than those of Food Yeast.

V. T. S.

Gleanings

Vegetables for the fighting services Large quantities of vegetables and potatoes are now being produced in several provinces to meet the needs of the Defence Services and remove the disturbing effect which large Army demands inevitably have on the ordinary market meeting civilian needs.

Over a year ago certain provinces had embarked on their own schemes to meet Army requirements, and in January this year the Central Government initiated a general scheme under which each province would arrange for the production of enough vegetables for all the forces located within the province.

The quantity of potatoes needed in different areas was worked out as well as the different varieties and proportions of fresh vegetables needed for Indian and British troops. An order for 30,000 lb. of European type vegetable seeds was placed in the U. S. A. and (most of it) has already reached India.

Madras has started three schemes located in the Vizagapatam District, the Nilgiris and at the Hosur Cattle-Breeding Farm. The first-named scheme should be able to meet Army needs in the surrounding area.

The Nilgiri scheme will supply fresh vegetables to various military stations throughout the province, while the Hosur Farm aims at supplying 1000 lb. a day from now onwards.

Arrangements have been made to supply 29,000 tons of potatoes from the Nilgiris to meet the needs of the Army, of dehydrating firms and of the services in Ceylon. Three thousand two hundred acres are being put down to produce 12,000 tons this year. This will, to some extent, replace the large quantities that are now taken from supplies which, in normal times, are consumed by the civil population. *(Indian Information, Sept. 1, 1943)*

Coconut butter Coconut butter is being very largely used in place of dairy butter in the United Kingdom and France, and, before the war, it was largely

used in Germany. It can be used wherever dairy butter is used. Here is the process:—Grate or grind in a mill the meat of the nut as fine as it can be ground, and for the meat of each average nut add a pint of boiling water. Put this in a press, so that the milk can be squeezed out separate from the pulp. This milk can be used in place of cow's milk for any purpose, and is specially good with stewed fruit. To make butter, this milk can be separated in a separator, or let stand in a pan to let the cream rise, which it should do in about the same time as the cream in cow's milk. This can be set to ripen and churned in the usual way. The whole process is in every respect the same as in making dairy butter. Wash out the buttermilk; add salt to taste. As a rule, this butter is white, and annatto colouring can be added. According to the size of the nuts, it should take from six to ten nuts to make 1 lb. of butter. The churning should be done in a cool temperature, say, between 60 to 70 degrees. *(Agri. J. Fiji, June 1942)*

The manufacture of coconut oil from fresh coconut meat An interesting account of a process for extracting oil directly from fresh coconut meat without its conversion into copra, is given in the *Philippine Coconut Journal* by Pedro E. Torres. The author claims that oil extraction from copra suffers from several disadvantages of which the chief are:—

Despite utmost care in handling and storage, the oil produced always contains free fatty acids and is usually discoloured thereby requiring additional refining operations. The only by-products are copra meal and cake which are dirty and become rancid and can only be used for animal feeds.

He describes the necessary processes for direct oil extraction in chronological order and indicates types of equipment already in use for other common industries, that may be used for each purpose. He also indicates uses for by-products. Claims are made that the process is commercially feasible but no manufacturing costs are mentioned. *(Agril. J. Fiji, June 1942)*

The conversion of coconut oil into a solid crystalline mass. While engaged in the study of thermal decomposition of coconut oil, J. Banzon *(The Philippine Agriculturist Vol. XXVI, No. 5, p. 399)* observed that a particular catalyst had the unique property of converting coconut oil into a crystalline solid mass. The process is the simple distillation of coconut oil with ferric oxide or finely divided iron. The distillate thus obtained is dark yellowish with a bluish flourescence. On cooling, it sets to a crystalline greenish—yellowish mass, which may be purified by repeated washings with methylated spirits.

The purified product is a light, white, crystalline powder, tasteless, and with a faint odour similar to stearic acid. It melts sharply at 55°C., to a clear transparent, colourless liquid, and solidifies to a hard, rather brittle, crystalline solid. Owing to its close resemblance to paraffin, this solid may possibly be used interchangeably with the latter, as for example, in candle making. *(Agrl. J. Fiji, June 1942)*

Tamarind seed, a new sizing material How tamarind seed can be employed as a sizing material for cotton yarn, thereby replacing the starch obtained from materials now required more urgently as foodstuffs, is described in an article recently published in the *Indian Textile Journal* and now reprinted by the Forest Research Institute in their series of *Indian Forest Leaflets*. Mill trials suggest that these seeds will be used permanently for the purpose and not merely as a wartime measure. Hitherto, while large quantities of tamarind have been consumed in India, no use has been found for the seeds. ***(Indian Information, Sept. 1 1943)***

Hints for bee-keepers

For November, 1943

The prosperous season for the bees generally commences from this month. With the advent of the North East monsoon, ideal weather conditions for bee activity prevail and there is luxuriant vegetation everywhere. An abundant supply of pollen is available from *Periamanjal cholam* and sometimes from maize and *cumbu* also. The supply is augmented by a few other minor sources like safflower, sunflower, niger, brinjals, *Peltophorum* etc. Adequate quantities of nectar are collected from a variety of plants like sunflower, safflower, niger, bittergourd, dhaincha, fiddlestick tree (cetherexylon sp) sandal, soapnut (sapindus sp.) and from the *cholam* shoot bug. In response to the prevalent favourable weather and pasturage conditions, bees exhibit remarkable indoor and outdoor activity. Comb construction begins and the rate of breeding is accelerated. Comb-foundation sheets or old combs may now be given with advantage. The month is a favourable one to build up the strength of the colonies and thus have a large force of field bees ready for the ensuing honey season. The following manipulations will, to a considerable extent, help the natural increase of the population. Weak colonies can be united and built up into strong ones or the population of a strong and weak colony can be equalised by interchanging the positions of the hives when the bees are working briskly. Old queens may be discarded and young ones introduced in their place. If conditions are favourable, drone breeding, construction of queen cells and the subsequent issue of swarms may occur. Necessary steps should be taken to prevent these. Colonies in good working condition may require supers.

M. C. Cherian and S. Ramachandran.

Crop and Trade Reports

Cotton, Raw, in the Madras Province The receipts of loose cotton at presses and spinning mills in the Madras Province from 1st February to 24th September 1943 amounted to 3,38,551 bales of 400 lb. lint as against an estimate of 4,06,300 bales of the total crop of 1942-43. The receipts in the corresponding period of the previous year were 578,184 bales. A total quantity of 497,996 bales mainly of pressed cotton was received at spinning mills and 839 bales were exported by sea while 199,451 bales were imported by sea mainly from Karachi and Bombay.

(*From the Director of Agriculture, Madras.*)

Moffusil News and Notes

The Hospet Sugarcane Growers' Co-operative Union Limited, Hospet The Prize Distribution Day of the Hospet Sugarcane Growers' Co-operative Union Ltd. was held at the Municipal Office, Hospet, on the 7th September 1943. Mr. P. H. Rama Reddi, the Director of Agriculture, Madras presided. The Additional Joint Registrar of Co-operative Societies, Madras, the Sub-Collector, Hospet, and other District Officers, and a large number of *ryots* of Hospet and surrounding villages were present. Rao Sahib A. D. Thandu Mudaliar, the President of the Union, presented a report on the progress of the Union since its formation in 1938.

The prizes were in the form of agricultural implements such as improved ploughs, Madras Ridgers, etc., and were awarded to 41 members who grew the improved varieties of sugarcane and obtained the highest yields during the last five years. The Director of Agriculture in his concluding speech expressed his gratitude and pleasure in meeting such a concourse of *ryots*.

A small exhibition was also arranged on the occasion when important posters on Grow More Food were prominently displayed. C. N. M.

College and Estate News

Students' Corner The College reopened on the 4th instant and almost all the students have joined their classes. On the 14th the students of B. Sc. Ag. class II were taken on a week's tour to Mettupalayam, Coonoor, Ootacamund and Nanjanad for the study of local agriculture and plantation crops.

Games *Cricket* The first match of the Rhondy shield tournament played on 4th September against Victoria College, Palghat ended in time-draw: Victoria College 226 for 6 (Srikant 102 not out; K. S. Alwa 3 for 34) Agricultural College 71 for 6 (R. Narasimham 33).

M. Sc. Degree We are glad to announce that Sri L. Venkataratnam, B. Sc. (Ag.) was awarded the M. Sc. degree by the Madras University for his thesis entitled "Growth features and rooting habits in Sathgudi oranges (*Citrus Sinsensis* L. Osbeck) as influenced by root-stocks, and in mangoes (*Mangifera indica* L) as influenced by propagational methods".

OBITUARY

We regret to record the demise of Sri P. V. Hanumantha Rao, Asst. Agricultural Demonstrator, Virdachalam on 1—10—43, due to heart failure. His untimely death is deeply mourned by one and all of his colleagues. We convey our sympathies to the members of the bereaved family.

Departmental Notifications

Gazetted Service—Appointments

Sri T. S. Ramakrishna Ayyar and Sri C. S. Krishnaswami Ayyar, Assistants in Mycology are appointed to act as Assistant Mycologists with effect from 13-4-43 and 16—7—1943 respectively.

Postings

Sri M. P. Sankaran Nambiar on the expiry of his leave is reappointed to officiate as D. A. O. Sattur Vice Sri N. Subrahmanya Ayyar granted leave.

Sri S. Sitharama Pathrudu, D. A. O. Vizagapatam will hold full additional charge of the post of D. D. A. Northern Division, Guntur vice Sri T. Budhavidheya Rao Nayudu granted leave.

Leave

Sri N. Subramanya Ayyar, D. A. O. Sattur l. a. p. for 4 months from the date of relief.

Sri T. G. Anantharama Ayyar, D. A. O. Trichinopoly, l. a. p. for 1½ months from the date of relief.

Transfers and Postings

Name of officer	From	To
Janab Md. Fassuddin Sahib	Asst. in Cotton, Adoni	A. D. Nandigama
Sri Ch Venkatachalam	A. D. (on leave)	Special A. D. Chintapalli
„ R. Govindarama Ayyar	F. M. Pattukottai	Special A. D. Madras City
„ V. G Venkataramana Rao	A. D. Wallajah	Do.

,, S. Mahadeva Ayyar	A. D. Koilpatti	Special A. D. Trichinopoly Town
,, R. Alagiamanavalan	A. D. Punganur	Special A. D. Coimbatore Town
,, N. Sobhanadri	A. D. Tenali	Food Inspector, Tenali

Leave

Name of officer	Period of leave
Sri R. Shanmukasundaram, Asst. in charge of Fruit Stations, Mettupalayam	Earned leave for 30 days from the date of handing over charge
,, B. Shiva Rao, A. D. Tuni	Extension of l. a. p. on m. c. for 1 month and 17 days and on half average pay on m. c. for 2 months and 13 days from 29—8—43
,, K. Cherian Jacob, Asst. in Botany, Coimbatore	Extension of l. a. p. on m. c. for 2 months from 24—9—43
,, P. Seshadri Sarma Asst. in Dry Farming Developmental Research Scheme, Bellary	Extension of l. a. p. for 1 month from 1—9—43
,, S. Venkatraman, A. D. Nannilam	L. a. p. for 1½ months from 17—9—43.
,, M. Krishnaswamy, A. D. Dharmavaram	L. a. p. on m. c. for 4 months from 20—9—43
Janab Zainulabdeen Sahib, Asst. R. R. S. Buchireddipalam	Earned leave for 30 days from 5—10—43
Sri M. S. Purnalingam Pillai, Sub-Asst. Cotton Section, Coimbatore	L. a. p. for 3 months and 20 days from 5—10—43
,, C. Ekambaram, F. M. S. R. S. Gudiyattam	Earned leave for 45 days from 4—10—43
,, K. Kunhikrishnan Nambiar, Asst. in Millets, Coimbatore	L. a. p. for 1 month and 17 days from 25—10—43
,, K. Venkataswami, Asst. in Millets, Coimbatore	Earned leave for 34 days from 18—10—43